the upper zone of the left with honeycomb cavitation. Note the high position of the right leaflet of the diaphragm.

FIG. 7.—Epituberculosis; homogeneous shadow in the upper and middle zones of the right lung. The trachea is well shown.

FIG. 8.—Fibroid phthisis. Tubercle bacilli in the sputum for thirty-five years. Patient at work. Normal lung markings obscured by numerous fibrous bands; honeycomb cavitation in both upper zones.

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The Use of Tuberculin in the Diagnosis and Treatment of Tuberculosis

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DIAGNOSIS.—The Tuberculosis Medical Officer is often asked to decide the question whether a patient is or is not suffering from tuberculosis. The patient may, for example, have pleurisy or a history of hæmoptysis. After taking the history of the case, examining the patient carefully, and having the sputum, or other discharge, if any, examined, he may be able to give a definite opinion. But he frequently meets with cases in which, after the most careful examination, the diagnosis still remains in doubt. Even an X-ray photograph may not decide the matter.

It is of great importance to discover as soon as possible whether the case is one of tuberculosis or not. For if it can be stated with certainty that it is not, this is a great relief to the patient and his friends. On the other hand, if it be a case of tuberculosis, now is the time when it can almost certainly be cured if taken seriously. In order to be on the safe side, some medical officers treat a large number of doubtful cases as tubercular. But the number can be considerably reduced by testing with tuberculin, using the subcutaneous test, by which many more give a negative result than is the case with the Von Pirquet or the intradermal test. From January, 1913, to March, 1932, I have used the subcutaneous test in 798 doubtful cases. In 344 of these there was no reaction, and the patients were assured that they were not suffering from tuberculosis. This does not mean that they

were immune to tuberculosis for life. Of 344 non-reactors, five did suffer later from pulmonary tuberculosis with positive sputum. The 454 patients who reacted to the test doses were advised to take the matter seriously, and have either sanatorium or tuberculin treatment, and most of them did so. From 1913 to 1922, inclusive, there were 165 reactors, of whom 130 got at least three months treatment at a sanatorium or with tuberculin, and 35 got neither. In March, 1932, the condition of these was as follows:—

	TOTAL	AT WORK		UNFIT		DEAD	
		Number	per cent.	Number	per cent.	Number	per cent.
Treated at sanatorium or with tuberculin - -	130	87	66.9	6	4.6	37	28.5
Treated otherwise, or untreated - - -	35	15	42.9	2	5.7	18	51.4

As the average time that these cases were under observation was fourteen and a quarter years, the deaths among those treated at a sanatorium or with tuberculin were not much in excess of those of the general population, the deaths among the others being much greater.*

For the test doses, T. (old tuberculin human) is used.

The first test dose is T. ·0002 c.c. If no reaction follows, the dose is doubled over and over again until six doses have been given with negative results, when the case is pronounced "negative." Test doses are given once or twice a week according to convenience. The technique is the same as that described under "Treatment."

TREATMENT.—Before commencing treatment, or giving test doses, the patient is provided with a clinical thermometer, and told to take his temperature four times a day—before breakfast, at noon, at 4 p.m., and at 8 p.m. When doing so, he is told to keep the 'half-minute' thermometer in his mouth at least two minutes, keeping his lips closed all the time. If the temperature be found to exceed 99°F. at all, he is told to stay in bed till it no longer does so. He is then allowed to advance by easy stages till he can attend the Tuberculosis Dispensary without putting his temperature over 99°F. Once he can do this, tuberculin treatment may begin.

APPARATUS REQUIRED:

A sterilising tray and stand with spirit-lamp.

A 1 c.c. record syringe with platinum-iridium needles.

Eight 2-drachm bottles with glass stoppers, and small labels to match.

A bottle of methylated spirit.

A bottle of collodium flex.

A 1 c.c. bottle of T. (old tuberculin human).

A 1 c.c. bottle of P.T. (old tuberculin bovine).

A supply of cotton wool.

A glass-stoppered pint bottle of diluting fluid. This is water containing 0·8 per cent. of NaCl. and 0·5 per cent. of carbolic acid. The salt and water are boiled together, and the carbolic acid added to the solution when it has cooled.

A graduated pipette with rubber teat. The pipettes are made of special glass, so

* According to the Registrar-General's reports, the average death-rate among the whole population of Northern Ireland in the years 1913-30 was 16.3 per thousand. At this rate, 23.2 per cent. of the general population would die in fourteen and a quarter years.

that they can be heated in the spirit flame without breaking. Each pipette has a bulb blown on it, and is of such dimensions that the 1 c.c. mark is a little way above the bulb and the ·1 c.c. mark a little way below it. The stem below the latter mark is divided into tenths and hundredths, so that small quantities can be measured in it with great accuracy.

A pair of forceps for lifting the syringe from the sterilising tray.

TECHNIQUE.—By means of the pipette the following dilutions are made in the 2-drachm bottles, which have previously been sterilised and dried:—T. 1 in 10, and 1 in 100. Also P.T. 1 in 10, 1 in 100, 1 in 1,000, 1 in 10,000, and 1 in 100,000. These are set out in two rows as above, and the remaining 2-drachm bottle filled with diluting fluid and placed in the front row next to P.T. 1 in 100,000.

The patient's temperature record since his last visit, with his weight and pulse-rate, having been entered on his chart, the dose of tuberculin to be given is determined, and entered on the chart.

The back of the patient's upper arm is exposed and rubbed with cotton-wool moistened with methylated spirit, and the syringe is taken from the sterilising tray, and the water expelled from it with the piston. The needle is then held in the flame of the spirit-lamp till it is red-hot, when the piston is withdrawn. This ensures that the inside of the needle is dry, and that the liquid put into the syringe barrel from the pipette will not drip away through the needle before the piston is inserted.

The pipette is then taken from the sterilising tray and its stem moved about through the spirit flame, the nipple being meanwhile compressed and relaxed alternately, till the stem is seen to be dry inside and out. By this means two ends are secured: (1) Perfect sterilisation of the pipette, and (2) removal of water which, filling an unknown fraction of the stem, would interfere with accurate measurement.

The dose is now taken from the appropriate bottle with the pipette and transferred to the syringe; after which the stem of the pipette is twice filled with diluting fluid and emptied into the syringe. The patient's skin is pinched up and punctured by a quick downward stabbing movement of the syringe needle. (This hurts so little that the patient is not deterred from coming back.) The piston is then inserted into the barrel of the syringe. This compresses the air in the upper part of the barrel, and in so doing drives the liquid into the patient's arm without touching the liquid.

The needle is then withdrawn, and the puncture sealed with a few strands of cotton-wool and moistened with collodium flex.

By this method one can be sure that the dose has been accurately measured, and that the whole of it has entered the patient's body. That the precautions against sepsis are sufficient is shown by the fact that after tens of thousands of innoculations thus carried out, I have not known a single case of suppuration at the innoculation site.

DOSAGE.—If tubercle bacilli have been found in the sputum, or if the patient has reacted to the first test dose, I commence by giving P.T. ·000,0001 c.c. If the patient has received test doses, and did not react to the first of them, I commence

treatment with a dose which is one-hundredth part of that which caused the reaction.

If the first treatment dose produces no local or temperature reaction, the dose is doubled each time until some reaction is produced. If the reaction, when it occurs, has been such as to cause the temperature to exceed 99° F., this dose is repeated until it produces no reaction. Then the doses are again increased, but more gradually than before. The highest rate of increase that can be used without producing reactions is what is to be aimed at. Doses that are far below what would produce reactions have little or no effect on the disease, and may even have an adverse effect.

The percentage increase of dose that suits best varies between wide limits—one may say from ten per cent. to seventy per cent. The most suitable rate of increase has to be found by trial. It not only differs for different patients, but even for the same patient at different parts of his course of treatment. Success in giving tuberculin treatment depends on continually adapting the rate of increase to the patient.

INTERVALS BETWEEN DOSES.—I find the following scale of intervals satisfactory :

Dose.	*Interval.*
P.T. ·0000001 c.c. to P.T. ·00001 c.c.	Three or four days (i.e., injections are given twice a week).
P.T. ·00001 c.c. to P.T. ·001 c.c.	One week.
P.T. ·001 c.c., or T. ·0001 c.c., to T. ·001 c.c.	Two weeks.
T. ·001 c.c. to T. ·01 c.c.	Three weeks.
T. ·01 c.c. to T. ·1 c.c.	Four weeks
T. ·1 c.c. to T. ·2 c.c.	Six weeks.
Above T. ·2 c.c.	Eight weeks.

I usually change from P.T. to T. at the place indicated in the above table. Allowing for T. being ten times stronger than P.T., I meet with no unpleasant reactions on making the change.

This table applies to pulmonary cases. The only difference I make in non-pulmonary cases is that as soon as a dose is reached that causes a reaction, I lengthen the interval to a fortnight, even though the dose be less than P.T. ·001 c.c.

THE AIMS OF TUBERCULIN THERAPY.—There are two distinct advantages that may be gained by a series of properly regulated doses of tuberculin : (1) The healing of the lesion, and (2) control of the patient's temperature. It is well known that patients with pulmonary tuberculosis are liable to have their temperature raised on taking unaccustomed exercise. This is due to auto-inoculation, i.e., escape of tuberculin from the patient's lesion into his circulatory system; so that the rise of temperature is really a febrile tuberculin reaction. By a suitable series of tuberculin doses the amount of anti-toxin in the patient's system may be increased to such an extent that the amounts of tuberculin received by auto-inoculation become negligible.

DURATION OF TREATMENT.—If possible, the treatment should be continued till all signs of active tuberculosis, and all symptoms of the same, have disappeared, and for a further period of at least three months. In the case of those patients whose 'physical signs' do not disappear, but whose temperature has been controlled, control of the temperature should be maintained by continuing the administration of

tuberculin indefinitely. One patient who had a large cavity in one lung when she came nineteen years ago, is still under treatment, fit for light work. Her dose now exceeds T. ·5 c.c., and she comes for it only once in eight weeks.

RESULTS OF TREATMENT.—Some good results have been obtained by me in the treatment with tuberculin of tubercular adenitis, peritonitis, and nephritis, and in other non-pulmonary tubercular affections. But I am unable to make a comparison between these and others of a like nature treated without tuberculin. But in County Down there has been an opportunity to make such a comparison in regard to pulmonary cases. Every year, usually in the month of March, with the aid of my colleagues, I try to trace all the survivors among those whose names have been entered in our books as suffering from pulmonary tuberculosis; and we make a note as to whether each one is fit to work or not. We succeed in tracing almost all of them.

A comparison of the results of different methods of treatment needs to be made in a large number of cases that are reasonably comparable. Some patients have so little resisting power that no known method is able to check the disease. To say that a remedy is of no use because it fails, or is inapplicable, in such cases, would be foolish. In the comparison to which I am about to direct attention, no cases have been included in which death took place within six months from the time when the patients were first seen by the Tuberculosis Medical Officer. I have excluded also all cases in which tubercle bacilli were not found in the sputum. The prognosis in T.B. minus cases is very much better than in T.B. plus cases; and to mix them together in any investigation of this kind would only cause confusion.

With the above exceptions, all the patients whose names were entered in our books as suffering from pulmonary tuberculosis from 1913 till 1922, inclusive, are included, except a very few whom I have been unable to trace.

At the first examination, each case was marked as T.G. (Turban-Gerhardt) 1, 2, or 3, according to the extent of the disease in the lungs as revealed by physical examination. On this basis the cases have been divided into two groups—T.G. 1 and 2, and T.G. 3. This has been done because the prognosis is much better in the former.

In County Down we have no county sanatorium. Those patients to whom sanatorium treatment was granted were sent to one or other of two sanatoria. Both of these stipulated that they were for early cases or cases that had some prospect of recovering working power. Patients who did not show some sign of improvement were usually discharged before three months. In the comparison I have not classed as "Treated in Sanatorium" any patients who received less than three months' sanatorium treatment. Similarly, I have not classed as "Treated with Tuberculin" any who received less than three months tuberculin treatment. Most of these were treated at the Tuberculosis Dispensaries, but some were treated at home with tuberculin by their own doctors, under the direction of the Tuberculosis Medical Officer.

The group described as treated otherwise includes all who received neither sanatorium nor tuberculin treatment for three months. Some of them received one

CHART I- SHEWING PERCENTAGE OF PATIENTS AT WORK

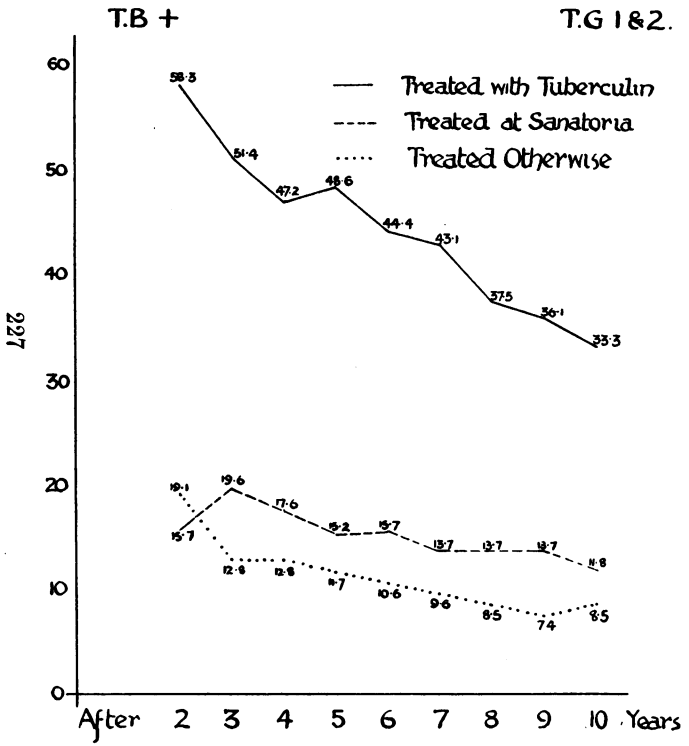
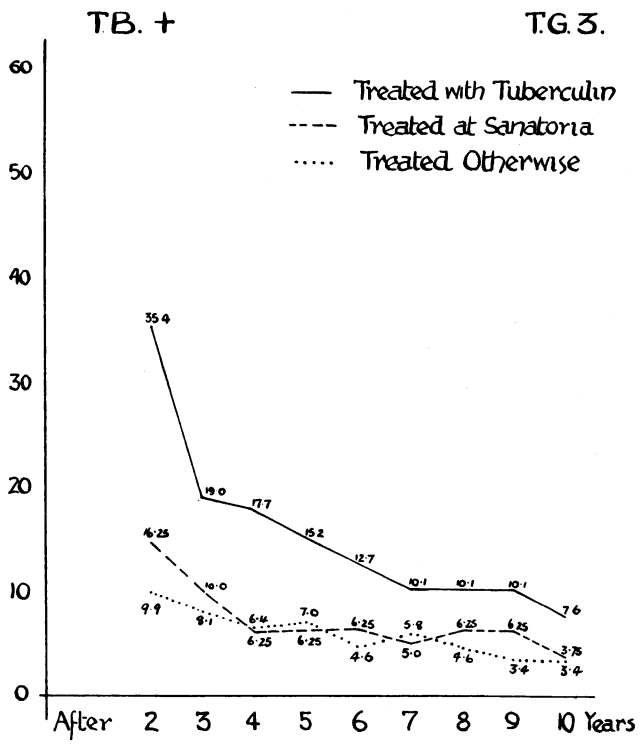


CHART II- SHEWING PERCENTAGE OF PATIENTS AT WORK



or the other for shorter periods. The few who received both sanatorium and tuberculin treatment for three months each have not been included. The accompanying charts show the percentage of patients treated in each of the three ways who were fit for work after two, three, four, five, six, seven, eight, nine, and ten years from the time when they were first seen, Chart I relating to T.G. 1 and 2 cases, and Chart II to T.G. 3 cases.

The superiority as regards working power of the tuberculin-treated patients over both the sanatorium-treated ones and the others is very striking, especially in Chart I.

In order to be able to give the results of tracing survivors for ten years, no cases that came under observation later than 1922 have been used in compiling the figures embodied in the charts. Thus the sanatorium-treated cases had only what is called simple sanatorium treatment, i.e., fresh air, good food, and graduated rest and exercise. At one of the sanatoria tuberculin was used for a time, but it was given by a rule of thumb method, the same series of doses being given to all patients.

None of these patients had artificial pneumothorax or sanocrysin, which have been introduced subsequently. When sufficient time has elapsed for these newer methods to produce their full effect, the sanatorium-treated cases should make a better showing. But they have a lot of leeway to make up before they equal the tuberculin-treated cases.

A Review of the Medical Methods of Treatment of Tuberculosis

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THE treatment of tuberculosis, it is said, has been forced into the ambit of State medicine, and the family doctor has, to a considerable extent, been compelled to give way to the health officer. This is especially true in the case of pulmonary tuberculosis, but so long as general practice retains its present position in the realm of professional medicine, so long must this disease command the interest and scientific attention of all general practitioners. They dare not relax their endeavours to keep abreast of the latest advances in the study of tuberculosis because of the present-day tendency to relegate it to a speciality. This is my justification for attempting to give an account of the aspects of the treatment of tuberculosis as they are applied in a large municipal sanatorium. In the Belfast Sanatorium we have accommodation for 290 patients, of whom approximately 200 are suffering from pulmonary disease and ninety from surgical and multiple lesions. These sections are segregated, and further, cases suffering from advanced forms of the disease are nursed separately from those affected with earlier and more amenable lesions.